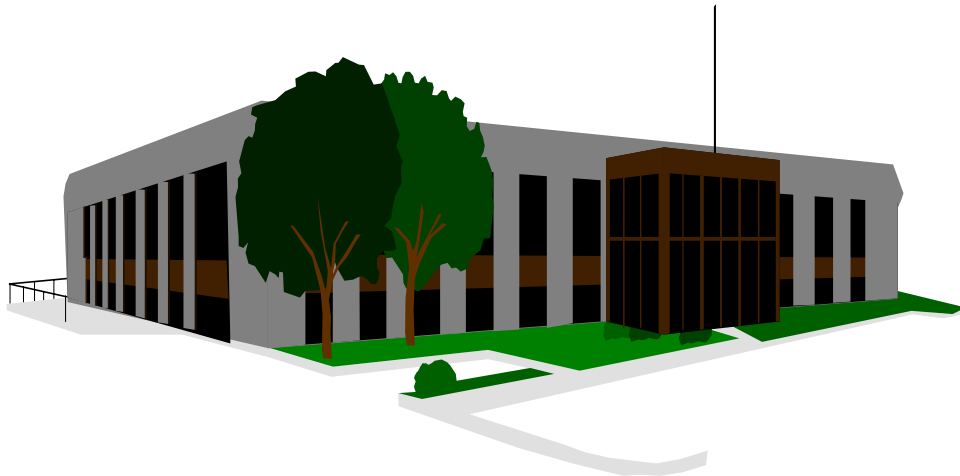


INDOOR AIR QUALITY ASSESSMENT

**Hull High School
180 Main Street
Hull, Massachusetts**



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
June, 2001

Background/Introduction

At the request of a parent, an indoor air assessment was done at the Hull High School (HHS) in Hull, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA). On March 28, 2001, a visit was made to this school by Cory Holmes, Environmental Analyst in the Emergency Response/Indoor Air Quality program, and Suzan Donahue, BEHA Research Assistant, to conduct an indoor air quality assessment.

The school is a two-story brick building built in 1957. Students from Hull Middle School temporarily occupy the second floor. The ground floor contains general classrooms, administrative offices, the gymnasium, cafeteria, wood shop, art room, and the boiler/custodian rooms. According to school officials the high school is tentatively scheduled for renovation in September of 2002.

A private consultant has previously evaluated the building in the spring of 1998 and in March 2001 (FLIE, 1998, FLIE, 2001). The 1998 general indoor air quality evaluation of the school made the following recommendations: 1) operate unit ventilators continuously throughout the day set at temperature levels to maintain comfort 2) review current classroom size to confirm that unit ventilators can properly supply the recommended minimum of 15 cubic feet per minute (CFM) of outside air per occupant, 3) replace water damaged ceiling tiles and building materials to reduce amplification of microbial growth, 4) affix antiglare screens to computer monitors to minimize headaches and eye strain, 5) cleaning and drainage of heating ventilation and air conditioning (HVAC) components (e.g., heating/cooling coils, drainage pans) and change filters to

prevent opportunities for microbial growth and 6) continue periodic IAQ sampling during heating and cooling seasons (FLIE, 1998).

The FLIE 2001 report concentrated on concerns of volatile organic compounds in room 116 (the art room). This report recommended: 1) equipping the art room with additional ventilation to circulate and exhaust air, 2) cleaning and operating the existing univent to provide the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) recommended minimum of 15 cubic feet per minute (CFM) of outside air per occupant and 3) continuing periodic IAQ sampling during heating and cooling seasons (FLIE, 2001).

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI Q-Trak, IAQ Monitor, Model 8551.

Results

This school currently has a student population of approximately 600 and a staff of approximately 65. The tests were taken during normal operations at the school, and test results appear in Tables 1-7.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million (ppm) in thirty-one out of forty-three areas surveyed, indicating an overall ventilation problem within the school. It should be noted that a large number of classrooms had open windows during the assessment, which greatly contributes to the reduction of carbon dioxide levels indoors. The MDPH approach to resolving indoor air quality problems is primarily two-fold, 1) improving ventilation to dilute and remove environmental pollutants and 2) reduce or eliminate potential exposure to materials that may be adversely affecting indoor air quality.

Fresh air in most classrooms is supplied by a unit ventilator (univent) system (see Picture 1). Univents draw air from outdoors through a fresh air intake located on the exterior walls of a building and return air through an air intake located at the base of each unit. The mixture of fresh and return air is drawn through a filter and a heating coil, and is then expelled from the univent by motorized fans through fresh air diffusers (see [Figure 1](#)). Univents were found turned off in classrooms throughout the school.

Obstructions to airflow, such as papers and books stored on univents and bookcases, carts and desks in front of univent returns were seen in a number of classrooms (see Picture 2). Some univents also contained accumulated dirt/debris. These univents should be cleaned before operating to prevent aerosolization of this material. In order for univents to provide fresh air as designed, intakes must remain free of obstructions. Importantly these units must remain “on” and allowed to operate while these rooms are occupied.

The mechanical exhaust ventilation system in the school consists of ducted, grated wall vents (see Picture 3). The location of exhaust vents can also limit exhaust

efficiency when the classroom hallway door is open. When a classroom door is open, exhaust vents will tend to draw air from both the hallway and the classroom. The open hallway door reduces the effectiveness of the exhaust vent to remove common environmental pollutants from classrooms. Without removal by the exhaust ventilation, normally occurring environmental pollutants can build up and lead to indoor air complaints. In addition, a number of exhaust vents were backdrafting cold air. Other vents were blocked by desks, chairs, boxes and file cabinets.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997, BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the

ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature measurements during the assessment were within BEHA's recommended comfort range of 70° F to 78° F (see Tables) with one exception. The faculty dining room had a temperature measurement of 66° F, however this room had open windows and exterior doors adjacent to either side of the room were also open. Although temperatures were within BEHA guidelines on the day of the assessment, a number of temperature control complaints were expressed to BEHA staff. It is difficult to control temperature and maintain comfort without operating the HVAC equipment as designed (e.g., univents deactivated and/or obstructed). In addition, the deterioration of window frames throughout the building allows for drafts to enter the building, which can contribute to cold complaints during the heating season. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in this building was below the BEHA recommended comfort range in all areas sampled. Relative humidity measurements ranged from 18 to 35 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

The school has well documented water penetration problems. In a large number of classroom water damage was seen on interior plaster, around windows and/or ceilings (see Pictures 4-6). The damage is most likely attributable to water penetration around window frames or through cracks in exterior wall bricks during rainstorms. As previously mentioned, window frames and panes are not watertight. Little, if any, caulking remains around windows. Cloth towels are used in a number of classrooms to absorb water leakage during rainstorms (see Picture 4). Towels used to soak up water around windows and other porous materials can serve as a mold growth medium; school officials reported that cloth towels are removed and laundered periodically to prevent microbial growth and associated odors. Numerous classrooms have water-damaged ceiling tiles from old roof leaks.

The exterior walls had spaces/cracks in brickwork. In many areas mortar around exterior brickwork appears to be crumbling or missing (see Pictures 7 & 8). These conditions are breaches of the building envelope and provide a means for water entry into the building. Repeated water penetration can result in the chronic wetting of building

materials and the potential for microbial growth. In addition large spaces may provide a means of egress for pests/rodents into the building.

Several classrooms contained a number of plants. Plant soil and drip pans can be a source of mold growth. In several areas outdoor window boxes/planters were seen inside the building (see Picture 9). Window planters are designed for outdoor use and are not usually equipped with drip pans, which can result in water pooling and potential microbial growth. Plant soil and drip pans can be a source of microbial growth. Plants should also be located away from univents and exhaust ventilation to prevent aerosolization of dirt, pollen or mold.

Room 114 contained a large fish tank containing standing water that was green with algal growth (see Picture 10). Aquariums should be properly maintained to prevent microbial/algal growth as they can emit unpleasant odors into the classroom.

Other Conditions

There are a number of stored materials, conditions or activities present in the school, which can effect indoor air quality. A letter with preliminary advice was issued giving recommendations on how to improve indoor air quality regarding flammable storage issues and bird infestation within the woodshop (MDPH, 2001). School staff reported that shop activities had not been conducted in the wood shop in several months due to the instructor's sick leave. However it was reported that the shop is being used as a classroom on occasion. Wood shavings and wood dust were observed on flat surfaces within the room, including on, around and in the interior of the univent. Wood dust can be irritating to the eyes, nose and respiratory system. In addition, under certain conditions, wood dust is a fire hazard.

Boiler room odors were detected in the technology wing (i.e., outside woodshop and art room). The boiler room door had spaces around the doorframe in this hallway. These spaces can serve as a means of egress for odors, fumes, dusts and vapors between the boiler room and the hallway. In addition, cans of paint, cleaning supplies, and other related materials, which contain volatile organic compounds (VOCs), were found stored throughout the school.

A number of conditions were observed in science classroom 112 and its adjacent storeroom that could have an adverse impact on indoor air quality.

- Acids and flammable materials were stored in an unlocked cabinet (to the rear of room 112)
- An unsecured helium tank was observed in the storeroom. Cylinders of compressed gas should be fixed to a wall or stand to prevent damage to the cylinder valves by tipping. A damaged cylinder valve can cause an immediate and uncontrolled release of the cylinder contents and may result in the cylinder becoming a projectile.
- Chemicals were noted stored in alphabetical order.
- A container of moth balls was sealed with plastic wrap and moth ball odors were noted in the vicinity of the container.

In addition, the chemical storage area has been reconfigured to provide office space. The local exhaust fan for the chemical storage area is currently located in the office area and is powered by a wall switch. Local exhaust ventilation should be operational at all times to prevent the build-up of vapors and odors that can off-gas.

Accumulated chalk dust was noted in several classrooms. Chalk dust is a fine particulate, which can be easily aerosolized and is an eye and respiratory irritant. Several classrooms contained dry erase boards and dry erase markers. Materials such as dry

erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Conclusions/Recommendations

A number of conditions were observed at HHS that can potentially affect indoor air quality. To improve air quality a number of remedial steps can be implemented. Some of these conditions can be remedied by actions of building occupants. Other remediation efforts will require alteration to the building structure and/or equipment. For these reasons a two-phase approach is required, consisting of more immediate (**short-term**) measures to improve air quality and **long-term** measures that will require planning and resources to adequately address the overall indoor air quality concerns. In view of the findings at the time of this visit, the following recommendations are made:

The following **short-term** recommendations are made:

1. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy.
2. Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room.
3. Inspect exhaust motors and belts periodically for proper function, repair and replace as necessary.
4. Remove all blockages from univents and exhaust vents.
5. Once both the fresh air supply and the exhaust ventilation are functioning properly, an HVAC engineer should balance the system.

6. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
7. Replace any remaining water-stained ceiling tiles and building materials. Examine the area above and around these areas for microbial growth. Disinfect areas of water leaks with an appropriate antimicrobial.
8. Move plants away from univents in classrooms. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary.
9. Clean and maintain aquariums and animal cages to prevent bacterial/mold growth and/or odors.
10. Replace missing ceiling tiles, to prevent the egress of dirt, dust and particulate matter into classrooms.
11. Have a chemical inventory done in all storage areas and classrooms. Properly store flammable materials in a manner consistent with the local fire code. Discard hazardous materials or empty containers of hazardous materials in a manner consistent with environmental statutes and regulations. Label chemical containers with the chemical name of its contents. Follow proper procedures for storing and securing hazardous materials.
12. Obtain Material Safety Data Sheets (MSDS) for chemicals from manufacturers or suppliers. Maintain these MSDS' and train individuals in the proper use, storage

and protective measures for each material in a manner consistent with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL, 1983).

13. Clean chalkboards and trays regularly to avoid the build-up of excessive chalk dust.

The following **long-term measures** should be considered:

1. Water-damaged wood materials should be replaced (e.g., wood flooring, windowsills, etc.). These materials can be a source of microbial growth. Sources of water leaks (e.g., window frames, plumbing, roof, etc.) should be identified and repaired. Examine the non-porous surface beneath/around these materials and disinfect with an appropriate antimicrobial.
2. Repair/replace missing or damaged window caulking and broken windows building-wide to prevent water penetration through window frames.
3. Examine the feasibility of re-pointing exterior brickwork.
4. Consider providing a dedicated local exhaust to the chemical storage area.

As previously mentioned the school is tentatively scheduled for renovation in the fall of 2002. In addition to the steps previously noted, the following recommendations should be implemented in order to reduce the migration of renovation generated pollutants into occupied areas. We suggest that these steps be taken on any renovation project within a public building:

1. Establish communications between all parties involved with building renovations to prevent potential IAQ problems. Develop a forum for occupants to express concerns about renovations as well as a program to resolve IAQ issues.

2. Develop a notification system for building occupants immediately adjacent to construction activities to report construction/renovation-related odors and/or dust(s) problems to the building administrator. Have these concerns relayed to the contractor in a manner to allow for a timely remediation of the problem.
3. When possible, schedule projects which produce large amounts of dusts, odors and emissions during unoccupied periods or periods of low occupancy.
4. Disseminate scheduling itinerary to all affected parties. This can be done in the form of meetings, newsletters or weekly bulletins.
5. Use local exhaust ventilation and isolation techniques to control for renovation pollutants. Precautions should be taken to avoid the re-entrainment of these materials into the school's HVAC system. The design of each system must be assessed to determine how it may be impacted by renovation activities. Specific HVAC protection requirements pertain to the return, central filtration and supply components of the ventilation system. This may entail shutting down systems (when possible) during periods of heavy construction and demolition, ensuring systems are isolated from contaminated environments, sealing ventilation openings with plastic and utilizing filters with a higher dust spot efficiency where needed (SMACNA, 1995).
6. Obtain Material Safety Data Sheets (MSDS) for all construction materials used during renovations and keep them in an area that is accessible to all individuals during periods of building operations as required by the Massachusetts Right-To-Know Act (MGL, 1983).
7. Consult MSDS' for any material applied to the effected area during renovation(s) including any sealant, carpet adhesive, tile mastic, flooring and/or roofing

- materials. Provide proper ventilation and allow sufficient curing time as per the manufacturer's instructions concerning these materials.
8. Seal utility holes, spaces in floor decking and temporary walls to eliminate pollutant paths of migration. Seal holes created by missing tiles in ceiling temporarily to prevent renovation pollutant migration.
 9. If possible, relocate susceptible persons and those with pre-existing medical conditions (e.g., hypersensitivity, asthma) away from areas of renovations.
 10. Implement prudent housekeeping and work site practices to minimize exposure to renovation pollutants. This may include constructing barriers, sealing off areas, and temporarily relocating furniture and supplies. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended.
 11. Consider changing filters for HVAC equipment more regularly in areas impacted by renovation activities. Examine the feasibility of acquiring more efficient filters for these units.

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Picture 1



Classroom Univent

Picture 2



Univent Obstructed by Materials

Picture 3



Classroom Exhaust Vent Note Open Door

Picture 4



Water Damaged Window Frames, Note Deterioration of Wood and Cloths Absorbing Water

Picture 5



Water Damaged Ceiling Tiles

Picture 6



Cloths Stationed in front of Exterior Door to Absorb Water

Picture 7



**Missing/Damaged Mortar in Exterior Brick
(pen inserted into wall to provide scale for hole size)**

Picture 8



(Damaged Vent) Pathway for Pests/Rodents into Building

Picture 9



**Window Planter inside Building Note Water Damage as Evidenced by
Dark Stains on Exterior of Window Box**

Picture 10



Aquarium with Algal Growth

TABLE 1

Indoor Air Test Results – Hull High School, Hull, MA – March 28, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	341	46	44					Weather conditions: cool, breezy
201	1259	75	28	9	Yes	Yes	Yes	Univent blocked, window open, dry erase board, missing CT (20+)
Library	1391	76	24	7	Yes			Missing CT, water damaged CT, 4 ceiling fans, dry erase board
Middle School Office	953	75	24	2	No	No	Yes	Exhaust off, photocopier, are carpet, door open
Hallway between Main Office & 204								Missing/water damaged CT, risograph, water fountain-clogged drain
205	1644	73	27	22	Yes	Yes	Yes	Univent fan and exhaust off, sink-cleaning products below, flowering plants, personal fan, dry erase board, door open
207	1655	73	28	26	Yes	Yes	Yes	Univent fan and exhaust off, sink, plants, dry erase board, door open
Giatakos/Quinn Office	2192	73	31	9	Yes	No	Yes	Dry erase board
212	1531	73	29	0	Yes	Yes		Univent fan off, dry erase board
202	1336	73	29	19	Yes	Yes	Yes	Univent off, window open, 10+ water damaged CT, water damaged wooden

* ppm = parts per million parts of air
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 2

Indoor Air Test Results – Hull High School, Hull, MA – March 28, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
								windowsills-towels on sills to absorb water
203	1266	76	28	47	Yes	Yes	Yes	Classroom at double occupancy, univent off, 20+water damaged interlocking ceiling tiles, window open
204	1518	76	28	26	Yes	Yes	Yes	Exhaust off-backdraft, 2 plants, water damaged wooden windowsill-towels to absorb water
206	1680	75	25	20	Yes	Yes	Yes	Univent off, exhaust off-backdraft, 2 plants, 13 water damaged CT, window and door open
208	1320	77	27	22	Yes	Yes	Yes	Univent off, exhaust blocked by cabinet, 20+ water damaged CT, window open
209	1293	76	26	23	Yes	Yes	Yes	Exhaust off, missing CT, 50+ water damaged CT, window open
210	1377	73	27	8	Yes	Yes	Yes	Window and door open, 2 missing CT
211	1116	74	26	12	Yes	Yes	Yes	14 water damaged CT
110	975	73	25	0	Yes	Yes	Yes	Exhaust off-back draft, window open, chalk dust, towels in window

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Relative Humidity - 40 - 60%

TABLE 3

Indoor Air Test Results – Hull High School, Hull, MA – March 28, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
107	1506	78	29	26	Yes	Yes	Yes	Exhaust blocked by boxes, window open
106	716	77	22	3	Yes	Yes	Yes	28 computers, 20+ water damaged CT, window open
104 Guidance Suite	663	77	22	1	Yes	Yes	Yes	20+ water damaged CT, missing CT, univent obstructed, former classroom subdivided into offices-univent in main area/exhaust in corner office, window mounted A/C
103	644	76	22	1	Yes	Yes	Yes	Wooden window planter over univent-flowering plants, window planter on top of newspapers-saturated
Attendance Office	781	75	23	0	No	Yes	Yes	Passive supply, air purifier
213	784	72	25	0	Yes	Yes	Yes	Window open, dry erase board, water damaged CT
111	765	76	22	11	Yes	Yes	Yes	~20 water damaged CT near window, 2 missing windows-plywood
Girl's Restroom						Yes	Yes	Passive door vent, exhaust weak/off, cigarettes
Faculty Room (Women's Restroom)	1180	78	24	3	Yes	Yes	Yes	Missing CT

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Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 4

Indoor Air Test Results – Hull High School, Hull, MA – March 28, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
side)								
Faculty Room (Dining Area)	875	78	24	3	Yes	No	Yes	Soda cans for recycling in cardboard box
Faculty Room (Men's Restroom side)	954	78	23	1	Yes	Yes	Yes	Risograph, 2 plants
105	529	76	18	7	Yes	Yes	Yes	Dry erase board, window open
101 Nurse's Office	658	78	25	1	Yes	Yes	Yes	Flowering plants over univent, exterior door-water damage
119A		70	29	3	Yes	No	No	Window open, dry erase board, plants
Auditorium	715	72	23	10	No	Yes	Yes	Currently being used as classroom
121 Music room	1189	73	27	11	Yes	Yes	Yes	
Cafeteria	1100			~140	Yes	Yes	Yes	4 univents, exhaust off, window open
Faculty Dining Room	689	66	24	0	Yes	Yes	Yes	Passive supply, window open, 2 missing CT, historic complaints of vehicle exhaust odors, adjacent to loading dock

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CT = ceiling tiles

Comfort Guidelines

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Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 5

Indoor Air Test Results – Hull High School, Hull, MA – March 28, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
119 Nutrition	1136	73	31	17	Yes	Yes	Yes	Former Home Ec. Room, pilot light out on gas stove-(left front), local exhaust fan in window-deactivated, local dryer exhaust-disconnected
Gym	688	74	23	5	No	Yes	Yes	Exhaust off
Shop Area Hallway								Boiler room odors, space under boiler room door
Woodshop					No woodshop activities for several months, woodshop storeroom-flammables cabinet-vented to outside/cardboard boxes inside/off-gassing materials/vintage metal containers (corroded)/bird wastes/carcasses, some woodshop equipment vented-some not, accumulated wood-dust, unsealed container of polyurethane & wood stain on table, flammables not in flammables cabinet, fountain-sink-no water			
114	1208	75	25	18	Yes	Yes	Yes	Exhaust vent partially blocked, items on univent, dry erase board build-up, lg. aquarium with standing water/algal growth
Science Hallway								Sheets/towels against exterior door to absorb water, door bases water damaged/corroded
112	937	75	25	11	Yes	Yes	Yes	20+ water damaged CT, acids stored under vent hood. Incubator

* ppm = parts per million parts of air
CT = ceiling tiles

Comfort Guidelines

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600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 6

Indoor Air Test Results – Hull High School, Hull, MA – March 28, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
120 Pre-school	947	72	29	7	Yes	Yes	Yes	Carpets, window open, dry erase board, cleaners under sink
117	607	75	20	6	Yes	Yes	Yes	15 computers, window open
116	905	77	23	16	Yes			Window open, no supply/exhaust could be identified, accumulated items, student sanding with hand sander in classroom
A/V Room	923	78	25	0	No	No	No	Personal fan-on, spray cleaners on shelf
115	2153	78	28	20	Yes	Yes		Dry erase board, aquarium, plant
113	919	73	23	9	Yes	Yes	Yes	
112	937	75	25	11	Yes	Yes	Yes	20+ water damaged CT, acids stored under vent hood
Chemical Storage Area					Ceiling mounted exhaust fan-deactivated, chemicals stored alphabetically, part of storage area converted to office space-local exhaust powered by wall switch, unsecured helium tank, flammables locker in classroom unlocked, mothball odors-sealed with plastic wrap			
Outside – Afternoon	413	47	35					

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CT = ceiling tiles

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Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 7

Indoor Air Test Results – Hull High School, Hull, MA – March 28, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Perimeter Notes					Missing/damaged mortar/brick, water damaged wooden window frames, spaces around univent air intakes, holes in exterior brickwork, broken window			

Comfort Guidelines

* ppm = parts per million parts of air
CT = ceiling tiles

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%